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Wake-up Call for General Management: It's Technology Time (I)

Technology Management: A Missing Link in General Management

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Technology is Altering the Global Landscape

Accelerated technological change has become a fact and will continue to challenge industrial and societal development into the next century. That all areas of life and the economy are increasingly affected by technology is undisputed. Nearly every day, without really noticing it, we benefit from innovations which not long ago were inconceivable. For example, by merely touching a keyboard in Zurich it has become quite possible, via satellite, to steer a computer in Tokyo which transmits English translations of Japanese texts back to Switzerland. Groupware and communication networks such as the Internet facilitate real time availability of knowledge and thereby reshape business processes fundamentally. With the help of stereo-lithography, CAD data can transform a work specimen into a prototype within hours. Thanks to consistent process management the production time for locomotives has been reduced from months to weeks at ABB. Endoscopy allows complex medical operations to be performed without surgery. Banks have more than doubled their internal productivity by means of optical character reading. Gene technology harbors a potential for yet incalculable changes in biological and pharmaceutical research and production. Finally, nanotechnology is opening the door to innovations which will revolutionize industry in the 21st century, such as tera-bit memories. The use of tera-bit memories will allow us to store the entire classical music repertoire of all times on one single CD.

The Perils of Missing the Technology Boat

Approaching the next Millennium, companies face an unparalleled range of challenges to the success and prosperity of their business. According to a recent survey by Deloitte Touche Tohmatsu International on the major success factors as perceived by the top 1000 companies in France, Germany, The Netherlands and the United Kingdom, the impact of technology has been identified as the single most significant factor of concern.

Moreover, technology and coping with technological change have become prime factors for the competitiveness of nations, and, due to the far-reaching societal effects of technologies, their deployment has become a prime issue for development.

Technology can provide untold opportunity to those who know its ways and manage it wisely; it can sound a death knell to those who underestimate its potential or miscalculate its effects. The now deceased US consumer electronics industry and the vibrant Japanese electronics industry of the 70s, 80s and early 90s provide sharply contrasting examples. Japanese management put technology and its management at the very center of their visions for the future; US management saw the industry in the 60s as mature, and unworthy of little more than cost cutting, aggressive pricing and beefed up marketing and promotion. What happened in consumer electronics is currently happening to those banks who failed to recognize that the "product" of banking is largely information, not money. Britain's First Direct Branchless Bank is a shining example of an organization (Midland Bank in fact) which saw technology as an opportunity and capitalized on it substantially ahead of its competitors.

Technology Management: A Missing Link in General Management

How can we explain these fundamental differences in managerial perception and action - differences which in the extreme lead to life or death scenarios for an individual firm or even a whole industry sector in one country or another? What did Sony do which Zenith did not? What did Midland bank do which NatWest missed? And what will the future giants of the emerging "nutrition" business at the interface of the food and pharma industry have to do to stay on top of the key technologies which will be central to *their* future? The general management literature is curiously silent on these issues. Typically, reference to the significance of technology is restricted to its non-binding inclusion in the list of factors influencing the enterprise. One reason for this critical gap between management theory and technology reality may be that theories in business administration have their roots in the mercantile education which per se has been focused in the past on non-technological issues. This may also explain why various technology university institutions, because of their technology culture and competence, began only late to engage in research and teaching in the area of technology management.

What Is Technology Management?

Technology Management is focused in its core on the creation and deployment of technology. *Technology comprises specific individual and collective knowledge in explicit or implicit form facilitating deployment of scientific and engineering knowledge.* This deployment of technology is directed on the one hand towards the development and maintenance of products and the corresponding production and administrative processes (e.g. scattering light technology, spark erosion technology, laser technology, groupware technology). On the other hand it also includes the technology required to operate the company's infrastructure (e.g. building automation technology). The total of a company's deployed technology represents the technology potential being subjected to technology management.

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Early impulses for today's technology management concept came from the USA. In a critical evaluation of the current competitive situation in the USA by the US National Research Council in 1987 it was concluded that a lasting improvement in a situation assessed as threatening could only be made by building up effective technology management as "The Key to America's Competitive Future" - in research, teaching and management practice. In this context "Technology Management" is perceived as linking "....engineering, science and management disciplines to plan, develop and accomplish the strategic and operational objectives of an organization" (Figure 1, left).
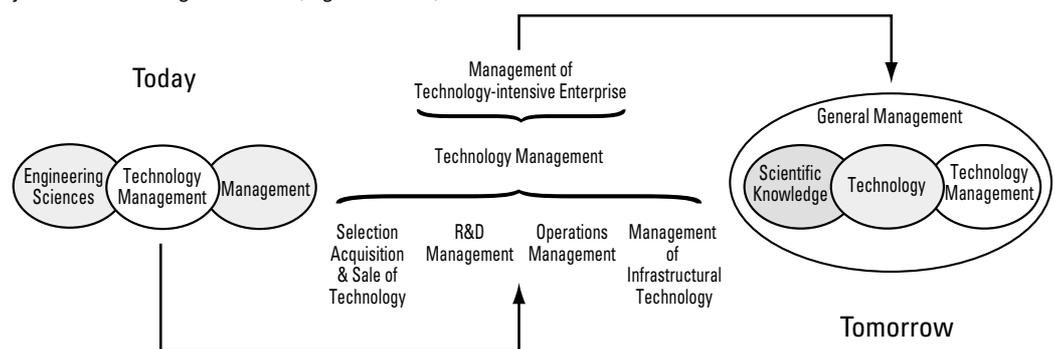

Figure 1 Various perceptions of technology management

The broad scope of technology management today ranges from the management of the acquisition and sale of technology, to the management of R&D and production, to the management of infrastructural technologies, and reflects a vast variety of differing approaches (Figure 1, middle).

In view of the gap mentioned above it is postulated that in the future technology management will gradually develop into an approach focused on management of technology-intensive enterprises. This reflects *a paradigm shift* insofar as "technology issues" - even under the responsibility of technology management - will no longer be of concern solely for technology-related management functions but rather of prime concern for general management on all levels of management (Figure 1, right).

Moreover, technology management is inseparably linked to innovation management with respect to product innovation as well as infrastructural and business innovation.

Building Technology Management Into General Management

At one extreme, technology management may be viewed as synonymous with R&D management; at the other, which I argue strongly for here, it is part and parcel of general management with important normative, strategic and operating components on the one hand, and structural, activity-based and behavioral dimensions on the other.

These three levels of management representative for general management[1] also play a role in the development and utilization of technology (Figure 2).

Firstly, on the *normative level,* primary decisions must be made according to the long-term goals of the enterprise. This requires the development of a *company policy* consistent with -the technology policy *(normative objectives).* At the same time an awareness of the culture permeating the company is essential *(normative behavior). Company culture includes the values held collectively by its employees, which is expressed, for example, in how employees identify with company goals and in the company´s behavior towards the environment, and manifest themselves in the company´s ability to change and innovate and to accept optimization of technology and work rather than maximizing technology deployment alone.* On the normative level it is not only the making of long-term *decisions which* is vital for the firm's future. Just as essential is who makes these decisions (normative structures). This question involves the upper decision-making levels of the company. The far-reaching nature of technology decisions requires that technology expertise be applied to the decision-making process from the outset.

On the *strategic level* it is essential that company policy be transposed into comprehensible strategies *(strategic objectives).* Strategies lay middle-term emphasis on the selection of those technologies necessary for the development and production of present and future products and services. In particular, decisions are made as to whether these technologies will be developed in-house or in conjunction with other firms, or whether they will be purchased completely from other companies. Relevant trends in strategic technology management indicate that strategic alliances, process management and innovation- and innovation-boosting structures are taking on increasing significance, as is technology scanning and monitoring, i.e. the comprehensive and systematic collection and accumulation of information concerning existing and developing technologies *(strategic structures).* This "early warning function" is often referred to as *technology intelligence.* A further focus involves concepts of *socio-*technical systems *design* which postulate the quality of work-oriented deployment of technology *and* work. In terms of *strategic behavior* issues such as organizational learning , innovation, technological knowledge and methodological *competences* play a significant role.

Finally, on the *operational level* of management, responsibility is taken for transforming strategies into practice in the context of short-term goals *(operational objectives).* Operational management expresses itself, for example, in concrete R&D projects in which the necessary personnel, financial and instrumental resources are deployed according to a plan. Here the pointer is "doing things right", implying accordingly *the principle of efficiency.* To this end suitable project structures have to been chosen, such as simultaneous engineering and structures of informational flow *(operational structures).* Finally *operational behavior* includes best practices of managing professionals and measures to promote the formal and informal flow of information.

According to this view technology management can be conceived of as an integrated function of general management which is focused on the design, direction and development of the technology and innovation potential and directed towards the normative, strategic and operational objectives of an enterprise.
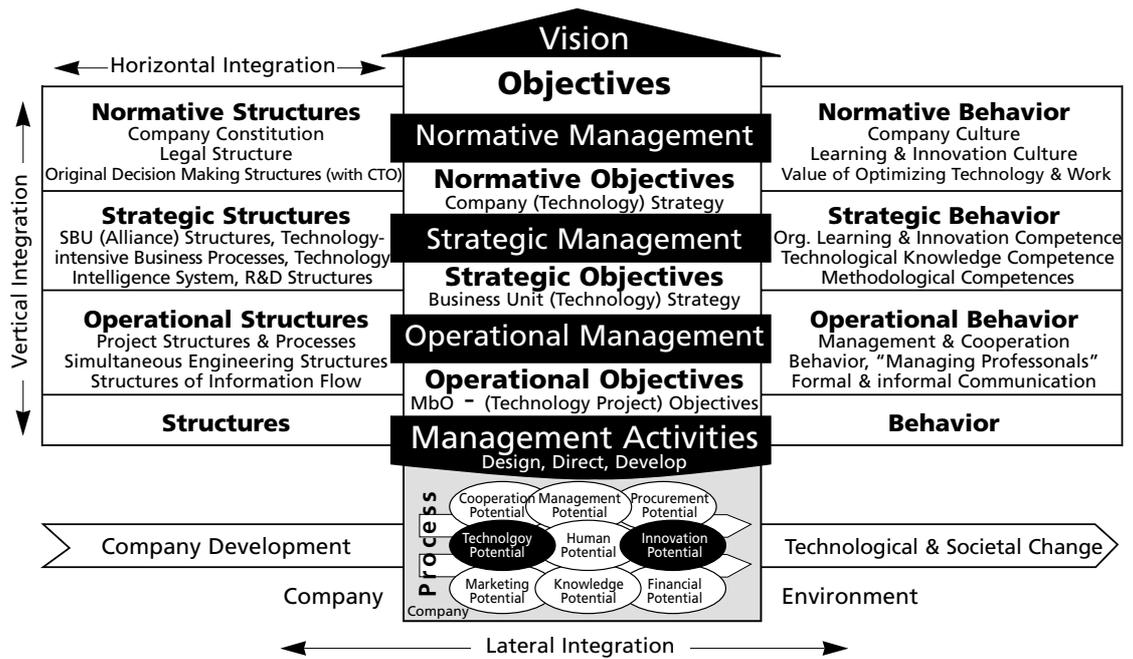
Three levels of management representative for general management also play a role in the development and utilization of technology.

Figure 2: Framework of Integrated Technology Management

Does Actively Practicing Technology Management Pay Off?

As always when attempting to relate business success to specific variables such as strategy, company culture, leadership or even entire management concepts, it is inherently difficult to come to unequivocal conclusions. A research study carried out at the Swiss Federal Institute of Technology on the "technology management intensity" of 60 SMEs belonging to branches of different technology levels, identified a group of obviously innovative and financially successful enterprises which are practicing technology management proactively on all management levels, and another group of non-innovative and non-successful firms in which technology issues are at best marginally integrated into processes of general management [2].

In addition an individual in-depth study of such renowned technology enterprises as ABB, Siemens, 3M, Canon, NEC, Hewlett Packard, Honda, Hilti, Novartis, Monsanto, Roche and others revealed a high awareness of technology and innovation management issues in manifold forms. Of particular interest is the fact that these companies do not take a singular but rather an integral approach to managing technology. They all simultaneously manage on the normative level in terms of explicit technology policy and innovative organizational culture, on the strategic level in terms of a clear focus on core technologies and at the same time on a high intensity of strategic technology alliances, and finally on the operational level in terms of up-to-date management instruments such as target costing, concurrent engineering project management, process management and the promotion of informal communication.

No crystal ball is required to predict a significantly increasing need for management awareness of technology and its management, as we face the unprecedented challenges of the next millennium. There are "good" and "bad" ways to go about this using the frameworks outlined above as well as others. This article has attempted to put technology management on the general management map. Many readers will now be wondering how to use this map to fundamentally change practices and directions. The sequel to this article describes six key pitfalls to avoid and how in fact to develop an integrated approach to technology management in a broad general management context.

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